DOCUMENT RESUME

ED 157 641 PS 010 077

AUTHOR Ball, William A.; Dibble, Ann
TITLE Perceived Movement in the Visual Crib.
PUB DATE Apr 78
NOTE 16p.; Paper presented at the Biennial Southeastern Conference on Human Development (5th, Atlanta, Georgia, April 27-29, 1978)

EDRS PRICE MF-$0.83 HC-$1.67 Plus Postage.
DESCRIPTORS Experiments; *Infant Behavior; *Infants; *Motion; *Perceptual Development; Perceptual Motor Coordination; Research; Self Control; *Stereopsis; Video Tape Recordings; *Visual Acuity

ABSTRACT

In this study, two similar depth perception experiments were conducted to investigate 3-month-old infants' perception of changes in depth while they were being moved. In the first, the subjects, 18 infants (80 to 105 days old) were lowered face down towards the textured floor of a 3-sided enclosure (visual crib). Three experimental conditions were used: babies were lowered until their heads were (1) in contact with the floor, (2) 10 cm. from the surface, and (3) 20 cm. from the surface. Head rotation occurring prior to any contact with the surface was considered withdrawal. In the second experiment, 8 infants (90 to 104 days old) were observed in three different stages of motion: (1) contact as in Experiment I, (2) approach to 20 cm. with a sharp deceleration at the end of the movement, and (3) horizontal motion near the surface of the crib. The procedure was similar to Experiment I except for the conditions of locomotion. Videotape recordings were made in both cases. Results indicated that infants perceive changes in depth during their own displacement, as the contact condition produced the greatest frequency of head withdrawal in both the experiments. (CM)

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Perceived Movement in the Visual Crib

William A. Ball

Swarthmore College

Ann Dibble

Swarthmore College

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Running head: Visual crib

Footnote: This paper is a revised version of one presented at the Fifth Biennial Southeastern Conference on Human Development, Atlanta, 1978. Reprints may be obtained from the first author at The Department of Psychology, Swarthmore College, Swarthmore, Pa. 19081.

Perceived Movement in the Visual Crib

Abstract

Infants 80 to 105 days old were lowered face down toward the textured floor of a three-sided enclosure. Head withdrawal away from the surface occurred when infants were about to contact it with their faces but not when the babies were stopped short of contact or merely moved horizontally near the floor. The results suggest that infants perceive movement in depth during their own displacement. It is speculated that head activity may provide a means for babies to learn to see the difference between locomotion and movement of the world.

Perceived Movement in the Visual Crib

The perception of movement along the line of sight is a special case of depth perception. During locomotion adult observers usually can see both that they, not the world, are in motion and that the distance to surfaces ahead of them is being reduced (Gibson, 1958, 1966). Lishman and Lee (1973) provided a dramatic demonstration that adults use vision in monitoring their own state of motion. Despite being objectively at rest, adults reported they were moving forward or backward when a surrounding, four-sided enclosure moved toward or away from them, respectively.

This line of work begun by Lishman and Lee has been extended to infants. Aronson and Lee (1974) observed 12-month-old babies standing in a four-sided enclosure. Movement of the walls of the enclosure toward the babies led to their falling backwards; movement of the wall away from the infants led to their tumbling forward. Babies "compensated" for their apparent movement by losing their balance in the opposite direction. Butterworth and Hicks (1977) obtained qualitatively similar behavior with seated 9-month-olds too young to stand.

When babies begin to monitor their own locomotion visually is unclear. Walters and Walk (1974) lowered babies toward a visual cliff, but infants did not show manual anticipation of contact with the surface of the cliff until 8 or 9 months. Bower (1977) has argued that findings such as those of Walters and Walk suggest that visual perception of locomotion does not emerge until the last third of the first year. He also followed Gibson (1966) in maintaining that the visual detection of locomotion depends on optical transformation of all elements in the visual field. Bower's view seems to be that such changes in the "optic array" might be too complex for young infants to process.

The latter argument is probably incorrect. Ball and Vurpillot (1976) examined perceived movement in depth of a "complex" display. They found that a filmed expansion pattern consisting of 800 discrete elements scattered over 100° of the visual field yielded consistent avoidance in babies 21 to 48 days old. Babies rotated their heads up and away from the projection screen as if avoiding an approaching surface. The "complex" changes of the Ball and Vurpillot work were more effective than stimuli consisting of expansions of one or three small elements each attaining a maximum size at expansion of 9°. Babies thus seem to use information about movement in depth that is provided by a transformation involving numerous elements within the visual field.

It should be noted that the large-scale expansion pattern of discrete elements is precisely the optical transformation that could theoretically have yielded perceived locomotion. That head withdrawal is produced during this whole-field expansion suggests that head movements might furnish an early index of whether babies detect depth changes while they themselves are moving. The infant's precocious head control was the basis for two studies of perceived movement in depth.

Experiment I

An experiment was performed to examine 3-month-old infants' perception of changes in depth while they were being moved. Babies were lowered face down toward the floor of a textured "visual crib." It was predicted that if infants perceived changes in depth during locomotion, their head withdrawal should be more likely the closer they came to a surface.

Method

Subjects. Of the 25 infants who visited the College, 7 failed to complete the session because of crying (2) or equipment failure (5). The remaining 8 boys and 10 girls ranged from 80 to 105 days (mean = 92 days). Baby's names were obtained from local birth announcements.

Material. The experimental space consisted of a three-sided enclosure (160 cm X 60 cm X 65 cm) the floor and walls of which were covered with the same pattern. The pattern was composed of a repeating design of interlocking, open squares (7.5 cm wide). One end of the enclosure had a window (27 X 21 cm) cut in it to allow placement of the television camera. The floor of the space formed a small "cliff" 7 cm high (from a side view).

The television camera of the videotape system was placed 130 cm from the edge of the cliff and, hence, was recessed 30 cm from the front wall. Its lens was surrounded by a large, flat piece of cardboard supporting the same pattern as on the walls.

The open end of the space displayed a rule callibrated in terms of distance above the top edge of the cliff. The markings were clearly visible in the television monitor. Lighting was provided by the overhead flourescent lights of the laboratory.

Procedure. Babies were brought to the laboratory by their parents. Parents were shown the procedure, and their written consent was obtained. An adult, either an experimenter or a parent, held the infant by placing an arm across the chest so that the arms were pinned to the sides. The babies were also supported under the thighs by the holder's other arm. This method of holding allowed the babies to be lowered in a prone position all the way to the floor of the enclosure without their arms or legs contacting the

surface.

There were three experimental conditions. Babies were lowered (1) until their heads contacted the floor, (2) until they were 10 cm from the surface and (3) until they were 20 cm from the surface. Infants were observed in blocks of six trials in each of the three conditions; the order of the three blocks of six trials was determined by a Latin square. Babies were always lowered a total distance of 40 cm. The rate and stopping point of the descent were controlled by having an assistant count out loud the 5 sec that each trial lasted, as well as note when the baby reached the correct distance above the surface. Descent was begun when the infants were judged to be looking in the general direction of the floor of the enclosure. Babies were allowed to rest for 2 or 3 minutes between blocks of trials.

The videotapes were scored for upward head rotation during the final 20 cm of descent. Only the last 20 cm were used to avoid confounding genuine avoidance with head movements due to inertial effects of starting to move. A maximum of one head withdrawal away from the floor was counted per trial, and reliability checks revealed 94% agreement between two observers in a trial by trial comparison of the recorded movements. It is to be emphasized that only upward head rotation occurring prior to any contact with the surface was considered withdrawal.

Results

Inspection of the data (cf., Table 1) suggested substantial deviation of the scores within a condition from normality as well as a clear tendency for the means and standard deviations to be correlated. Nonparametric methods of analysis thus seemed preferable to the usual analysis of variance. A

Friedman two-way "analysis of variance by ranks" (Siegel, 1956) revealed a substantial overall effect of the closeness of approach ($Chi_r^2 = 12.03$, $p < .01$).

Insert Table 1 about here

Matched pairs signed ranks tests (two-tails) indicated that the contact condition was more effective than either near approach ($T = 0$, $N = 12$, $p < .01$) or far approach ($T = 6$, $N = 14$, $p < .01$) in producing head rotation away from the surface. The latter two conditions did not differ ($T = 43.5$, $N = 7$). Avoidance was thus most likely in the case of imminent collision, and 14 of 18 infants withdrew their heads at least once prior to facial contact with the surface.

Within the contact condition, the data for each infant was pooled into blocks of two trials. A test for trends was then performed to determine whether the number of head rotations tended to increase over trials. No increase was observed, $F(2,34) = .17$; withdrawal from the surface was just as likely early in the sequence of contact trials as later. Thus, random fussing movements due to aversive, repeated contact with the surface could not have been responsible for babies' withdrawal. Avoidance was not learned during the experiment: Otherwise, some increase in the frequency of responding would have been observed across trials.

Discussion

Babies as young as 80 days seem to perceive depth changes while they are being displaced. Withdrawal from the surface was more likely just prior to "collision" than at 10 or 20 cm from the floor. The pattern of responding is

consistent with the view that withdrawal depended on visual detection of movement in depth.

It might be objected, however, that babies were not avoiding a surface, but were simply looking around the crib for something interesting to see. Also, it was possible that any slowing down near the surface of the space could have allowed the infants more time to move their heads than in the other two conditions, or the deceleration may itself have produced some sort of head withdrawal. A second experiment controlled for these possibilities.

Experiment II

Babies were observed in three different states of motion: 1) contact as in Experiment I, 2) appraoch to 20 cm but with a sharp deceleration at the end of the movement, and 3) horizontal motion near the surface of the crib. Only the contact condition should have produced withdrawal if the latter were specific to a condition of imminent collision. Neither horizontal motion very near the surface nor a "far" approach with a clear deceleration provide optical information specifying impending contact, and hence, they should have been ineffective in producing avoidance.

Method.

Subjects. Of the 10 subjects who came to the laboratory, two did not complete the session because of fussing. The remaining sample, consisting of six boys and two girls, averaged 96 days of age with a range of 90 to 104 days.

Procedure. The experimental space and disposition of the recording apparatus were the same as in Experiment I. The procedure was also like that of Experiment I except for the conditions of locomotion. The contact condition was as before, but the approach to 20 cm from the surface was accompanied by a deliberate deceleration over the last 2 sec of movement. Deceleration

was started when the observer's count reached 3 sec of the total of 5 sec that a trial lasted. Horizontal movement was produced by lowering the infant to a prone position beyond the edge of the cliff. Then, babies were moved toward the television camera such that they passed over the edge of the cliff and moved at 8 cm from the floor of the crib. They travelled 25 cm near the surface during 3 of the 5 sec of the trial. No head contact with the surface was made during the horizontal movements. Babies saw all conditions in a random order of three blocks of six trials, and scoring of the tapes was performed as in Experiment I.

Results.

The pattern of results was identical to that of Experiment I: The contact condition produced the greatest frequency of head withdrawal (see Table 2). A Freidman test showed a significant effect of the conditions ($Chi_r^2 = 6.81$, $p < .038$),

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Insert Table 2 about here

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and sign tests revealed that the contact condition produced more frequent avoidance than the other two ($N = 6$, $p < .04$, two tails). Neither the decelerating movement nor simple movement near the surface seems to produce avoidance. Babies' avoidance occurs most often during movement toward and near the surface. Visually perceived movement in depth thus seems to underly withdrawal, and hence, babies see changes in depth while they themselves are in motion.

General Discussion

Babies around 3 month old see movement in depth during their own displacement. Bower's argument (1977) that young babies cannot visually detect depth changes

during locomotion is probably incorrect. Head withdrawal occurred in the present work when babies were moved closer and closer to a surface but avoidance was rare when babies stopped short of the crib or simply moved horizontally.

A theoretically important ambiguity remains, however. Young babies' avoidance of a surface has been observed in two different situations: During movement of an object toward the infant (Ball & Tronick, 1971; Bower, Broughton & Moore, 1970) and during movement of the infant toward a surface. Babies under 3 months seem to detect a reduction in the distance between themselves and a surface, but present knowledge does not rule out the possibility that they do not see locomotion and movement of the world as different distal events. The same avoidance has been obtained during locomotion and movement of a part of the external world, displacement in depth of a single object. Hence, the meaning of the head withdrawal is ambiguous.

The purely optical conditions producing avoidance do not clarify its meaning. Optical magnification of a large display containing discrete textural elements (Ball and Vurpillot, 1976) resulted in head withdrawal in babies as young as 21 days. This condition provided an optical analogue to the visual transformation produced by locomotion toward a large, flat surface. Expansion of a single shadow--the optical equivalent of movement of a single object--also yielded head withdrawal (Ball & Tronick, 1971; Bower, Broughton, & Moore, 1970). Thus, the ambiguity noted for the perception of real locomotion or movement of an object has not been resolved by the infant's behavior in optical displays. The same avoidance occurs during visual transformations potentially ocrresponding to different, real states of motion.

The ambiguities raised by current work in perceived movement in depth highlight two developmental problems. It is possible that

perception of movement in depth and perception of the locus of movement have distinct developmental histories. The evidence suggests that withdrawal from an approaching surface is innate (Bower, 1977). Indeed, the first author has observed head withdrawal from an approaching object by his son, who was 18 hours old! The perception of movement in depth may thus be intrinsic to the nervous system, and optical expansion is a likely source of the stimulus information underlying the perception.

Perceiving a reduction in the distance between the observer and the observed does not logically entail, however, the concommitant perception of whether the observer or the observed is in motion. A potential source of information to infants about their state of motion is self-produced activity itself. Active movement is not seen in this view as being developmentally prior to perceived movement in depth. Instead, activity may serve to specify what optical changes correspond to locomotion. Surprisingly, displacement of the head has received little emphasis in the infant literature on spatial organization. Head movements such as arching away from a real crib surface produce optical transformations over the entire visual field. Head "locomotion" occurs long before actual crawling, and hence, it may provide an early occasion for the baby's correlating efforts to move with the resulting optical transformations. The visual re-afference (cf. Von Holst,1954) of active head movements toward or away from a surface is the very transformation of the whole visual field that seems to underly visually perceived locomotion in adults (Lishman & Lee,1973) and older

infants. Young babies could differentiate local transformations of the visual field not usually produced by head movements from simultaneous transformations of all elements in the visual field regularly produced by activity of the head. In both cases movement in depth would be seen, but only one optical transformation would eventually correspond to locomotion. Confirmation of this view will require the development of new indices of perceived approach and the use of a wider range of stimulus transformations corresponding to different types of motion.

References

Ball, W. & Tronick, E. Infant responses to impending collision: Optical and real. Science, 1971, 171, 818-820.

Ball, W. & Vurpillot, E. La perception du mouvement en profondeur chez le nourrisson. L'Année psychologique, 1976, 76, 393-400.

Bower, T. G. R. A primer of infant development. San Francisco: Freeman, 1977.

Bower, T. G. R., Broughton, J., & Moore, K. Infant responses to approaching objects: An indicator of response to distal variables. Perception & Psychophysics, 1970, 11, 193-196.

Butterworth, G., & Hicks, L. Visual proprioception and postural stability in infancy. Perception, in press.

Gibson, J. J. Visually controlled locomotion and visual orientation in animals. British Journal of Psychology, 1958, 49, 182-194.

Gibson, J. J. The senses considered as perceptual systems. Boston: Houghton-Mifflin Company, 1966.

Lishman, J. & Lee, D. N. The autonomy of visual kinesthesis. Perception, 1973, 2, 287-294.

Siegel, S. Nonparametric statistics. New York: McGraw Hill, 1956.

Van Holst, E. Relations between the central nervous system and the peripheral organs. British Journal of Animal Behavior, 1954, 2, 89-94.

Walters, C. & Walk, R. Visual placing by human infants. Journal of Experimental Child Psychology, 1974, 18, 34-40.

TABLE I

MEAN NUMBER OF HEAD ROTATIONS:

EXPERIMENT 1

CONTACT	NEAR APPROACH	FAR APPROACH
2.33 (1.91)	.39 (.83)	.44 (.54)

Note: Maximum Count = 6 and n = 18. Standard Deviations are in parentheses.

TABLE 2

MEAN NUMBER OF HEAD ROTATIONS

EXPERIMENT 2

CONTACT	HORIZONTAL DISPLACEMENT	SLOW FAR APPROACH
2.0 (1.69)	.25 (.46)	.50 (.75)

Note: Maximum count = 6 and $\underline{n}$ = 8. Standard deviations are in parentheses.